Virtual Tower Control

- From research prototypes to industrial deployment -

Jörn Jakobi, Markus Schmidt
ICAS Group,
Braunschweig, 2014-09-24

The Vision

- Virtual Tower Control -

Dr. Norbert Fürstenau
Michael Rudolph
Markus Schmidt
Dr. Bernd Werther

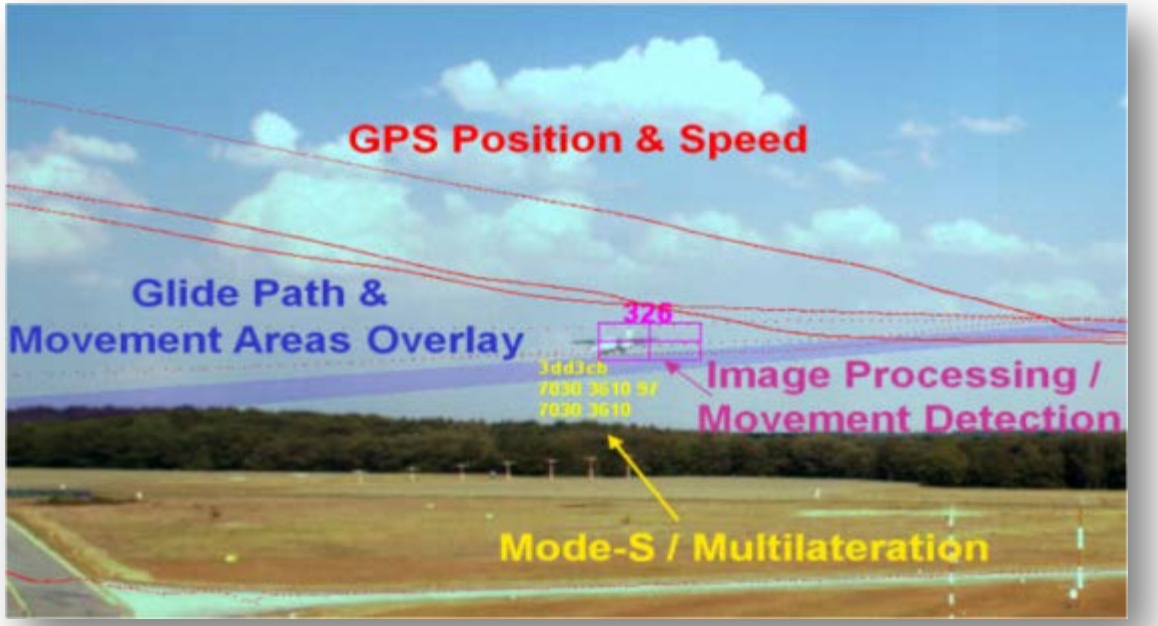
What is the core of this idea?

- **Cost Savings**!
  - Cost efficient allocation of personell by relatively small investment
- **Safety!**
  - Infrared Camera
  - Augmented Vision
  - Tracking

➔ **Sustaiability of cost efficent air traffic control**

Where remote control can be a solution?

1. RTO Center for 1+n
   small or medium sized airports
2. RTO Center for 1+n
   big airports
3. Remote Control of view restricted
   Apron oder Runways
4. Contingency



How did DLR contribute to the development of remote Tower?

RAiCOn 2010-2012

RTC DFS Auftrag 2012

RApTOr 2005-2008

2002

2005

2008

2011

2014

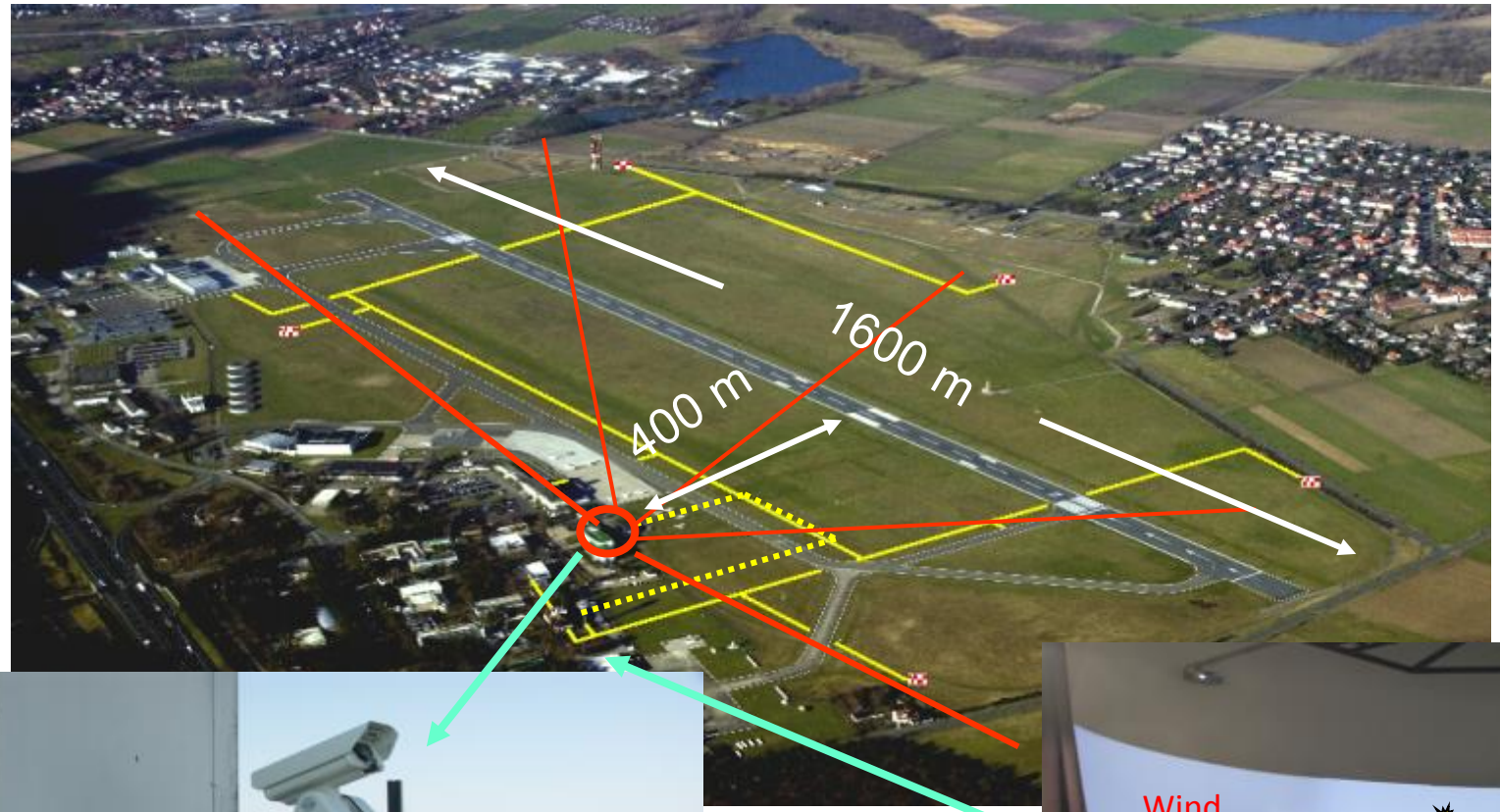
ViTo 2002-2004

VICTOR 2008-2012

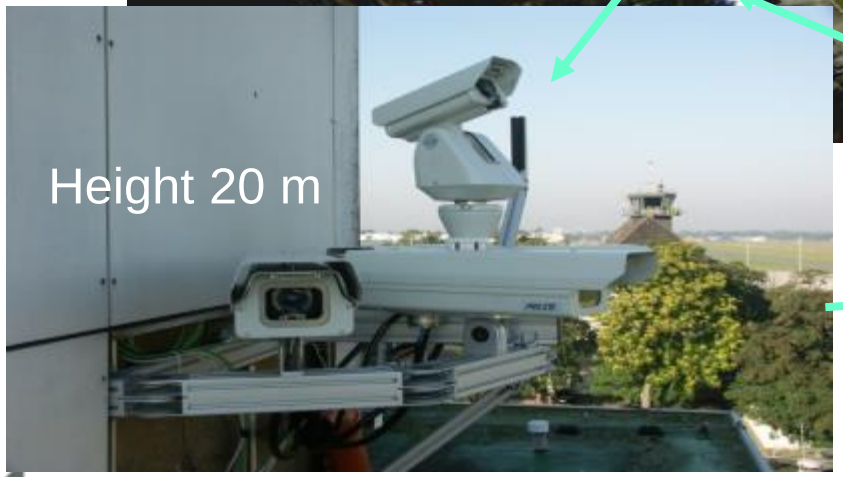
SESAR 2012-2015

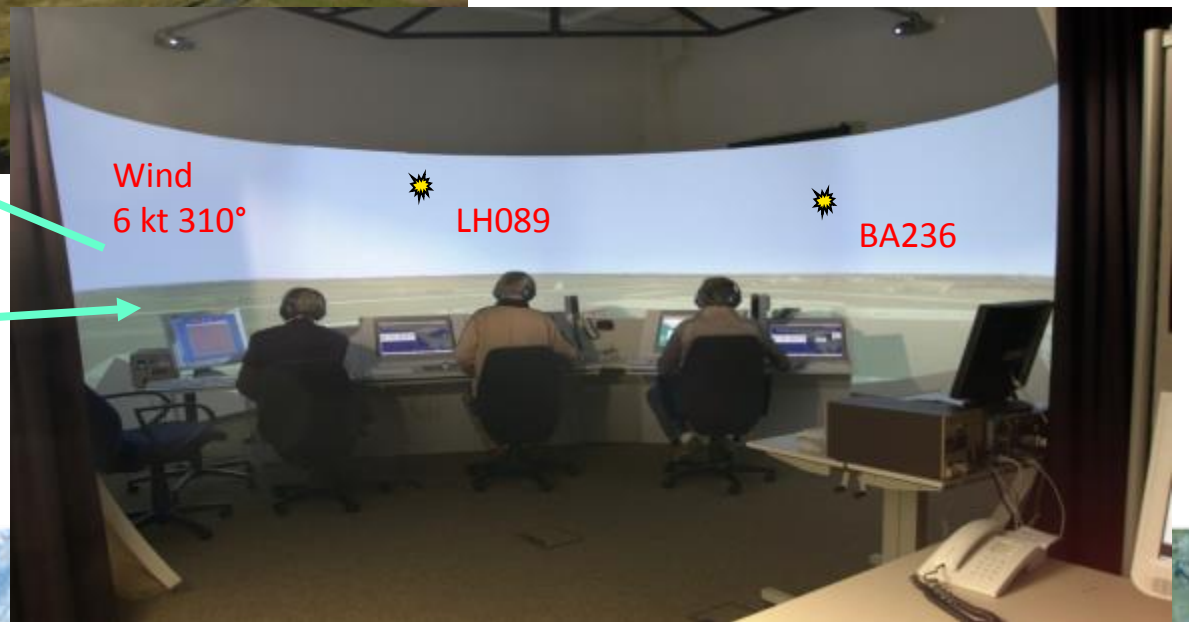
RAiCe 2008-2012

DLR Research Prototype at Braunschweig Airport (2006)



- Video system for panorama and image processing
- Gbit/s - Fibre optic LAN
- Experimental Augmented Vision HMI





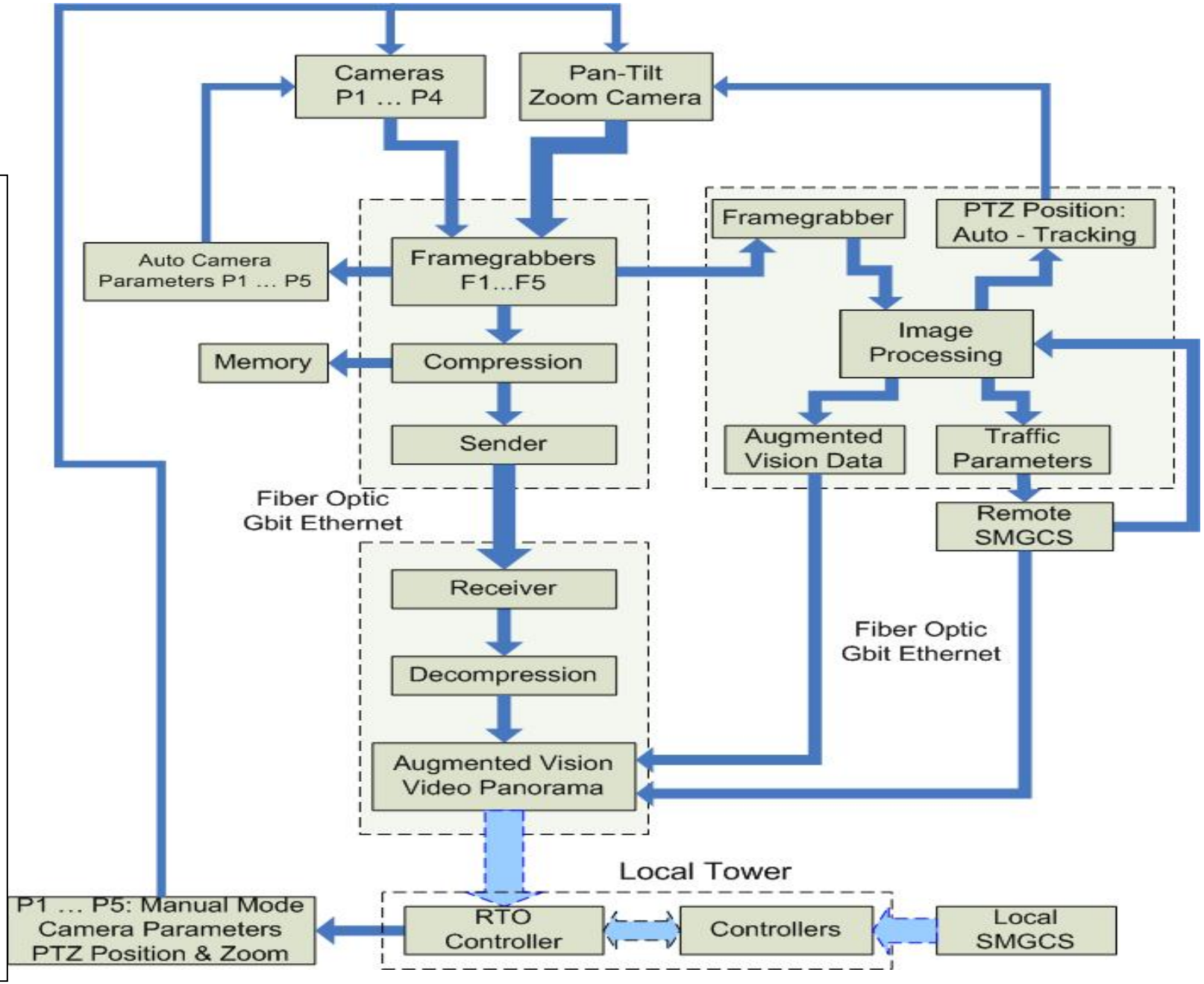
Functional Block Diagram

Technical Data

Cameras:
4 x (1600x1200), 14bit/pixel,
25 frames/s
PTZ: f = 3.6 – 82.8 mm, 23 fold
PTZ-IR
3 Fields of View (2°, 7° and 21°)
4-5µm MWIR, 640x512pixel,

Panorama:
Wide angle tiled projection with
4x2 SXGA (1280 x 1024)
2 arc min / pixel

Data Transfer:
GBit Ethernet, typically 100 MBit/s,
MJPEG compressed



Focus of our Research

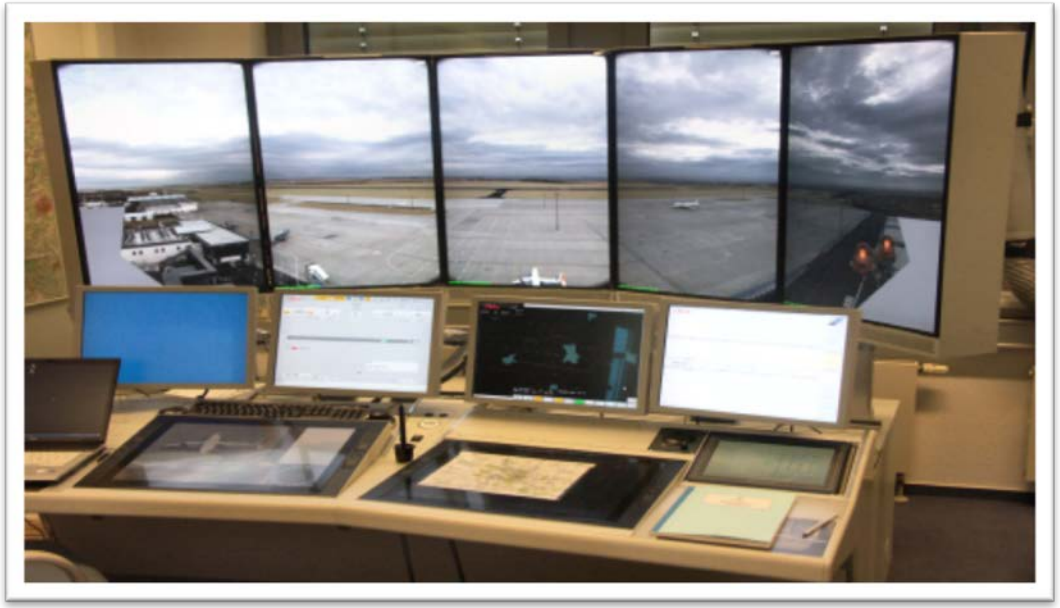
- Operational and technical proof of feasibility:
  - Operational & Performance Requirements
  - Situational Awareness
  - Usability
  - Acceptance
  - Safety Risk Assessment
  - Workload
  - Eye Point of Regard Measurements

DLR Remote Field-Test-Plattform, Research Airport Braunschweig

RAiCe (2010)
- first 1 to 2 Multiple Remote Simulation -

RAiCon (2010 - 2012)

- DFS-DLR-Collaboration
- Planning, Development, Set up, implementation and validation of a RTO prototype systems at Airport Erfurt



Field Test Plattform Erfurt

200° - Camera System:
5 x (1920x1080), 200° x 66°
12bit/pixel, 30 frames/s

Pan-Tilt-Zoom (PTZ) - Camera:
VGA-Resolution
continuous Rotation
23x Zoom, 1,7° - 40° Field of View

Panorama Wall:
5 HD-LCD – Monitors
2 Wacom – Displays
Visual Resolution 30cm/500m (2 arc min)

DLR/DFS Remote Feld-Test-Plattform, Tower Erfurt

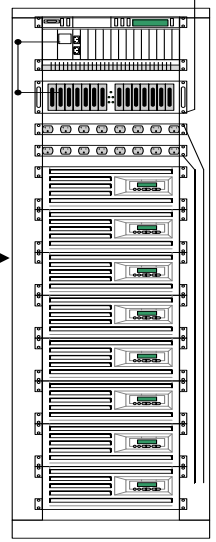
Set up of Research Prototyp Platform at Erfurt Tower, 2012

Cameras on top of the Tower Erfurt

Technical Test Station Braunschweig

WAN-broadcast

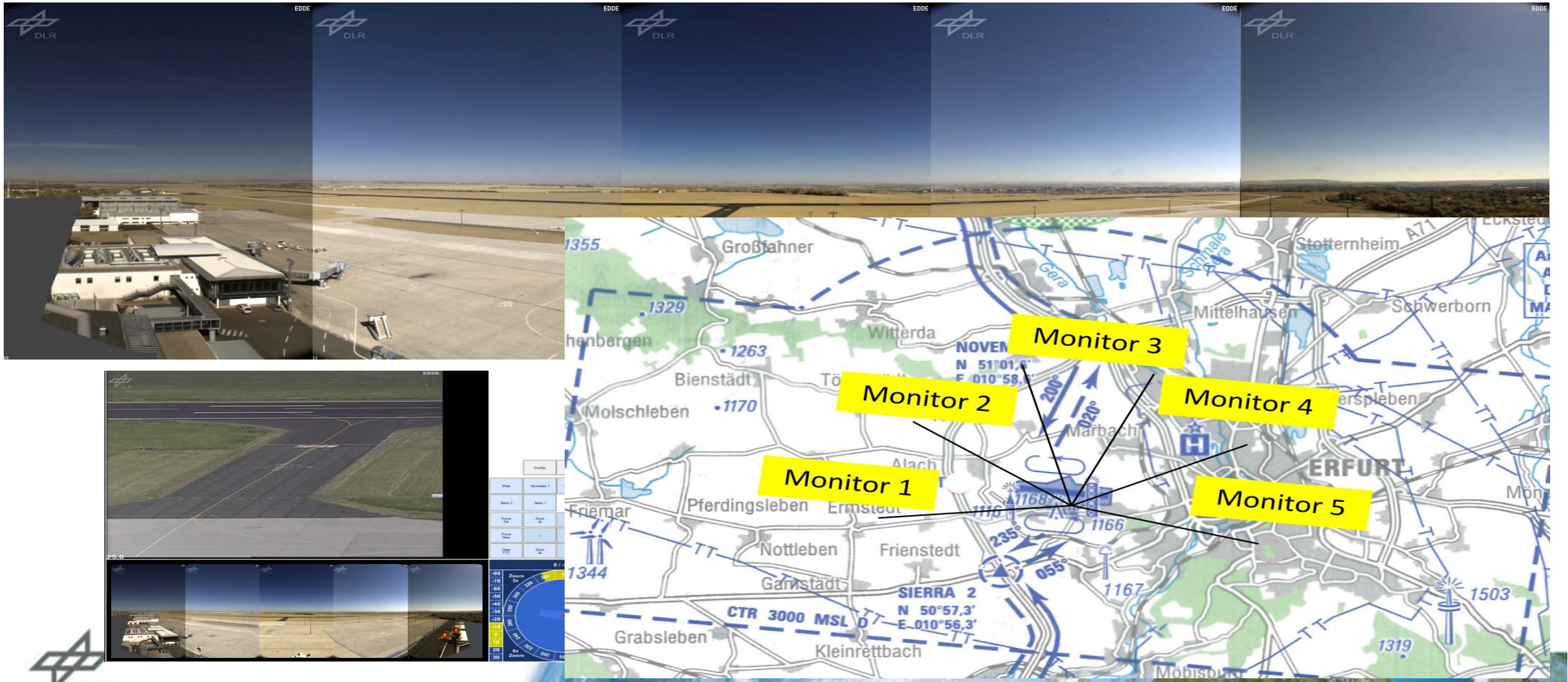
50Mbit/sec



Rack room of Tower Erfurt

Remote Position Erfurt Tower

Panoramic View and PTZ



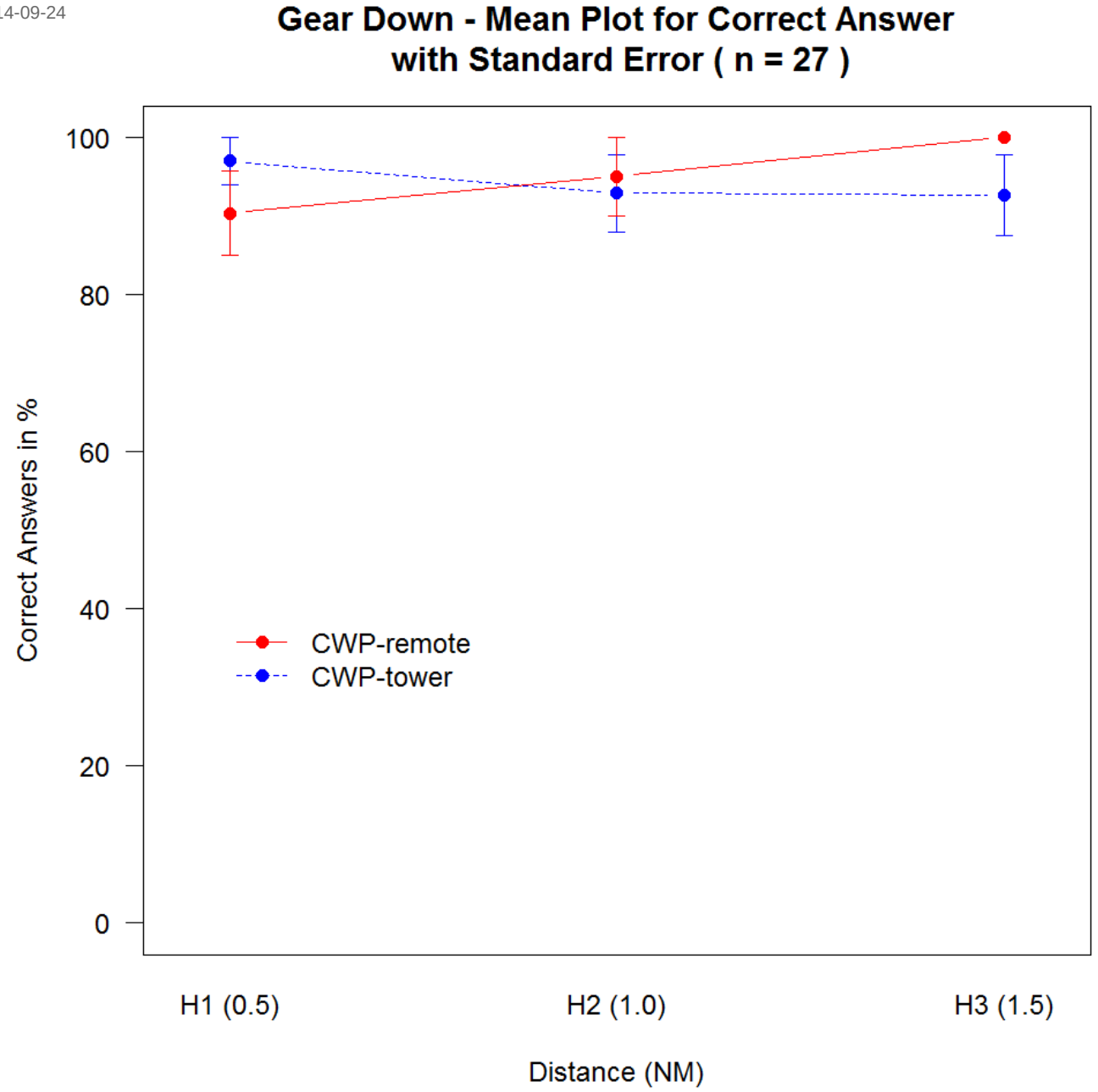
VCR
Position
Tower Erfurt

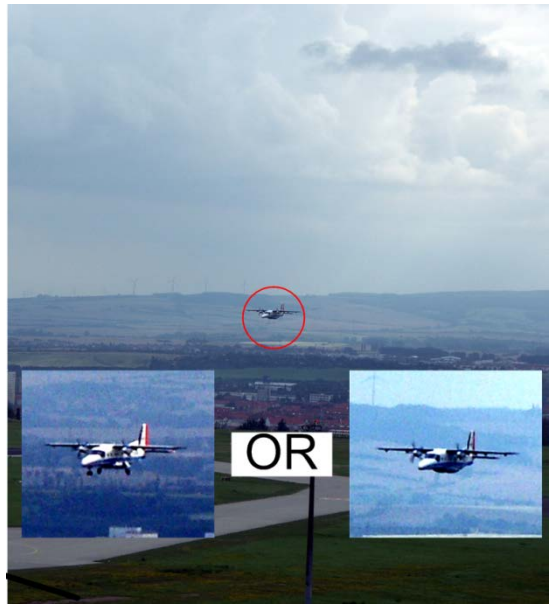
Comparison
of
Perception

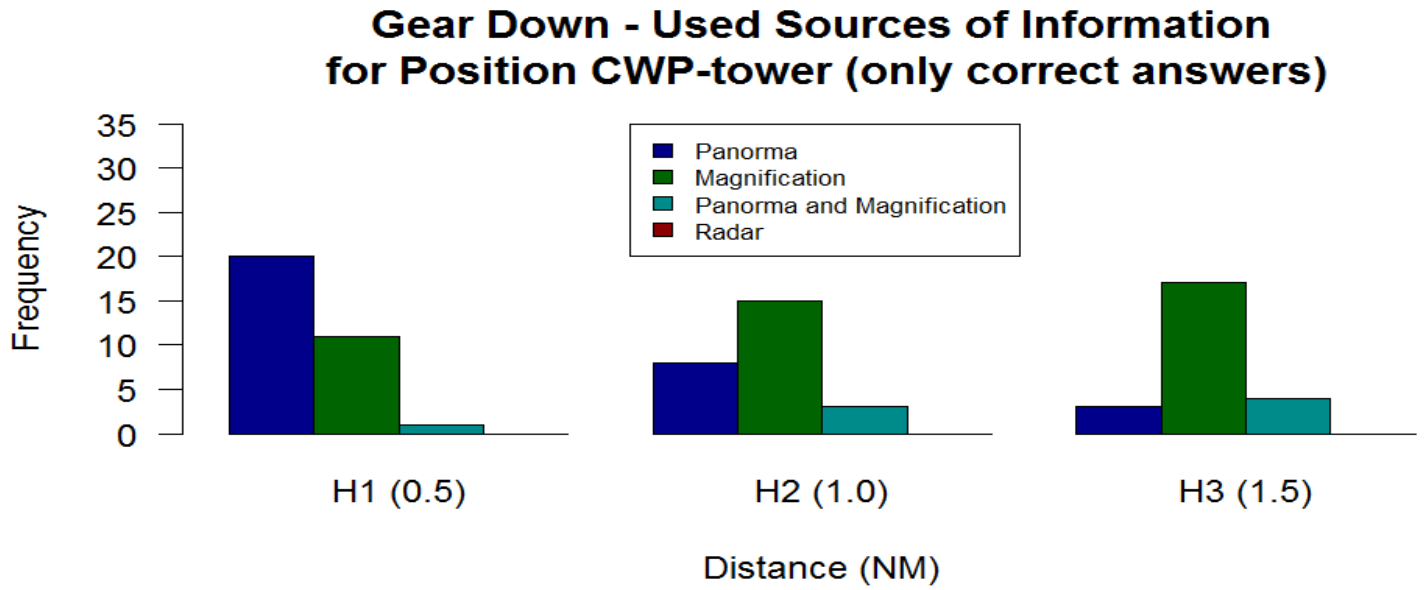
Remote
Position Tower
Erfurt

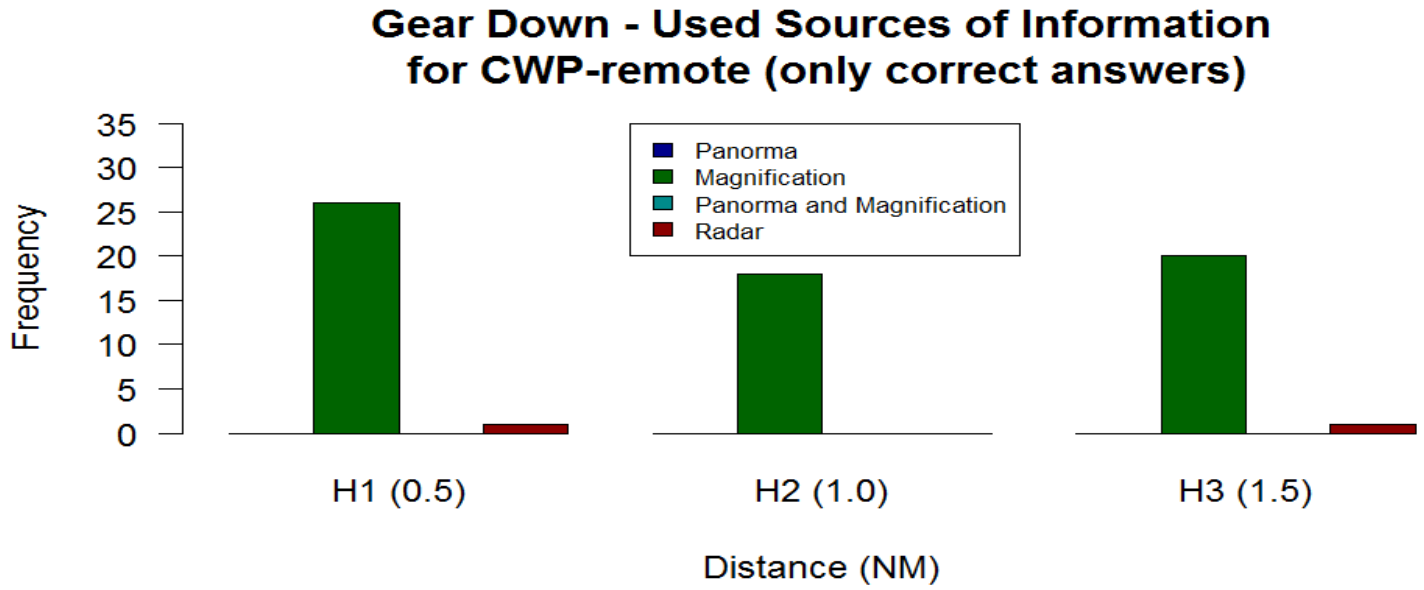
DLR Do228 Test Aircraft

Experimental Set up, Erfurt Tower, June 2012

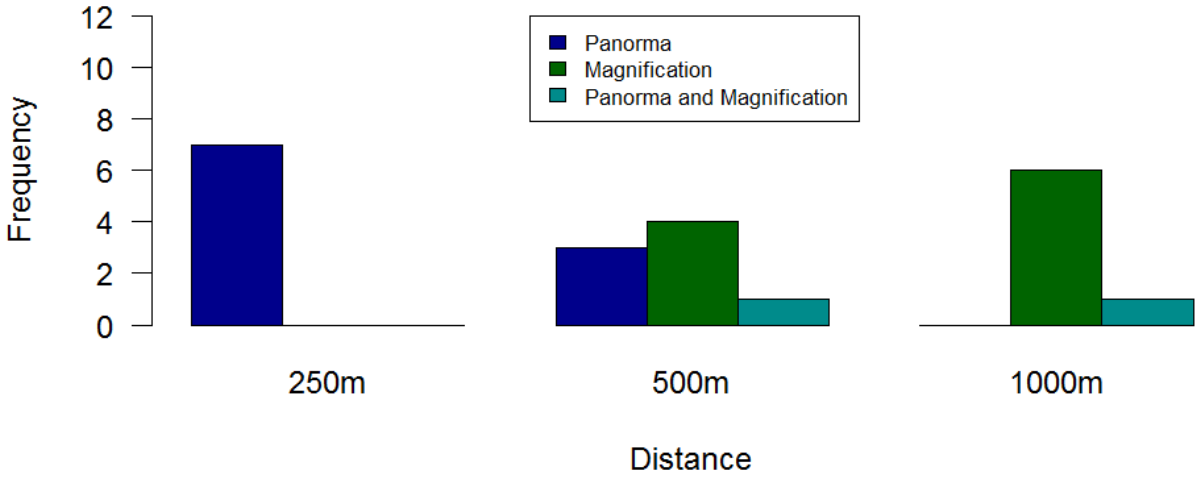

Gear Down - Mean Plot for Correct Answer
with Standard Error (n = 27)
Correct Answers in %
100
80
60
40
20
0
CWP-remote
CWP-tower
H1 (0.5)
H2 (1.0)
H3 (1.5)
Distance (NM)


OR

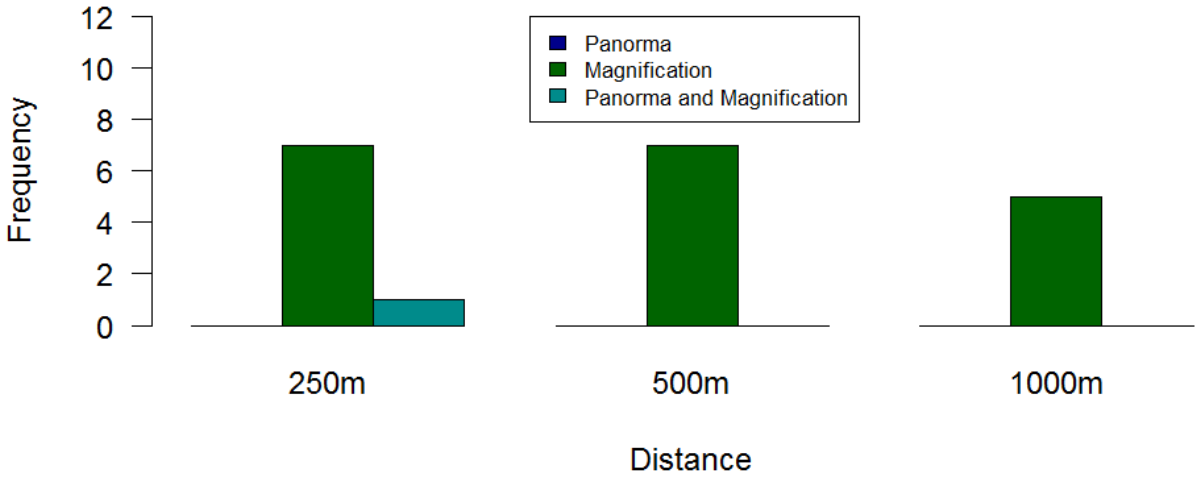

Gear Down - Used Sources of Information
for Position CWP-tower (only correct answers)
Frequency
35
30
25
20
15
10
5
0
Panorma
Magnification
Panorma and Magnification
Radar
H1 (0.5)
H2 (1.0)
H3 (1.5)
Distance (NM)


Gear Down - Used Sources of Information
for CWP-remote (only correct answers)
Frequency
35
30
25
20
15
10
5
0
Panorma
Magnification
Panorma and Magnification
Radar
H1 (0.5)
H2 (1.0)
H3 (1.5)
Distance (NM)

Static Objects - Used Sources of Information for Position CWP-tower (only correct answers)



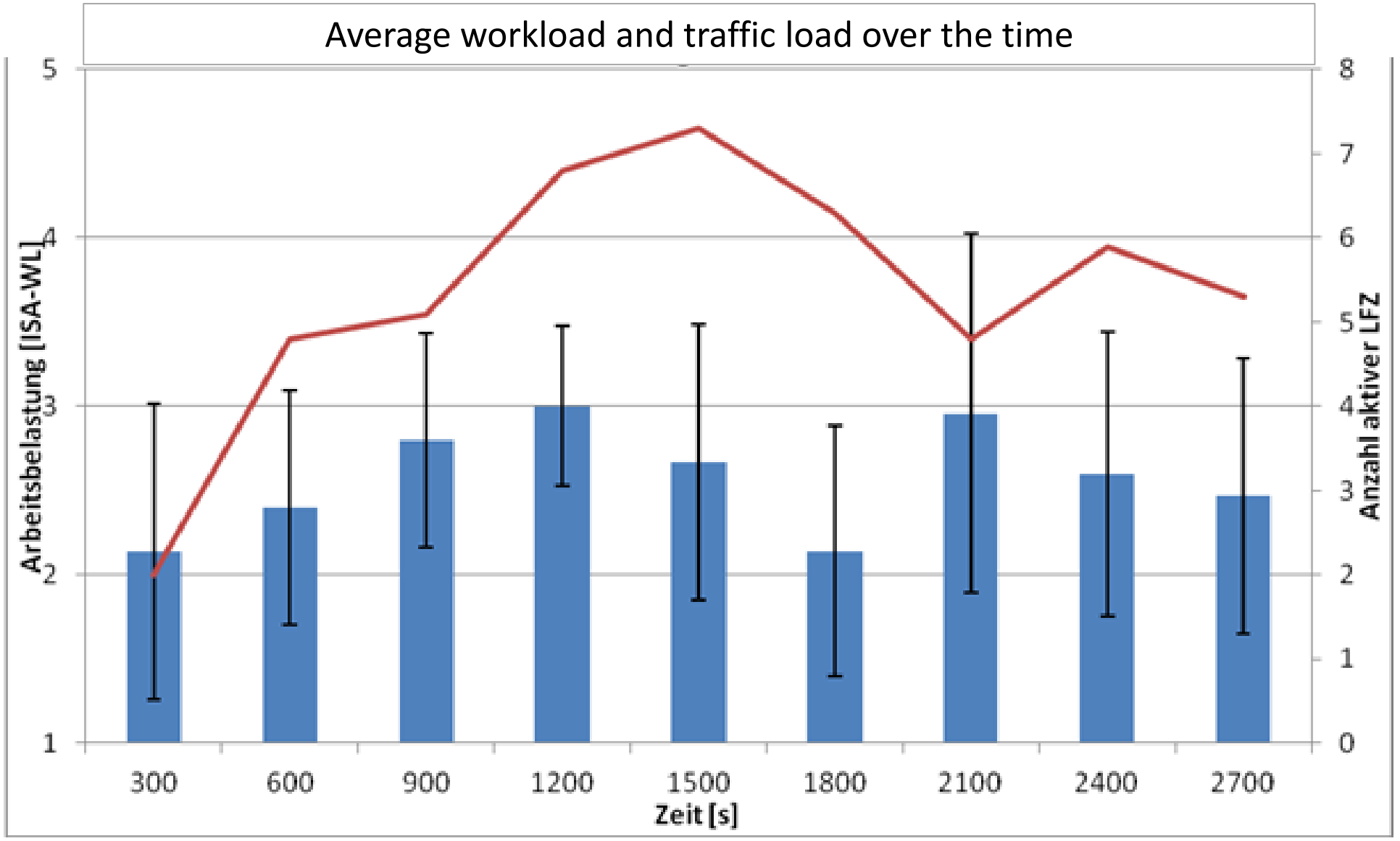
Static Objects - Used Sources of Information for CWP-remote (only correct answers)



DFS Human Factors Studie 1:1 Multiple Remote Concept

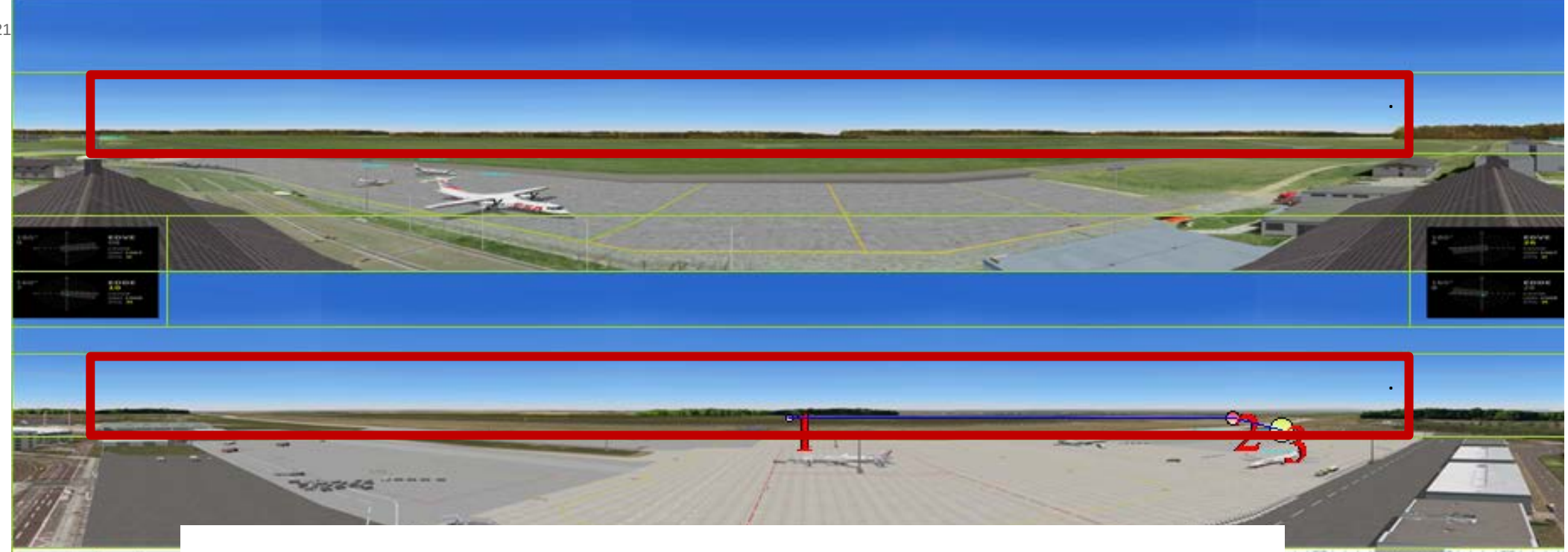
Feasibility Studie & Safety Assessment

Is a controller able to handle traffic via different airports safe and efficiently?


Average workload and traffic load over the time
Arbeitsbelastung [ISA-WL]
Anzahl aktiver LFZ
Zeit [s]
5
4
3
2
1
8
7
6
5
4
3
2
1
0
300
600
900
1200
1500
1800
2100
2400
2700

1:2 Multiple Remote Tower Center Simulation (SESAR, 2013)

Is a controller able to handle traffic simultaneously at two airports safe and efficiently?

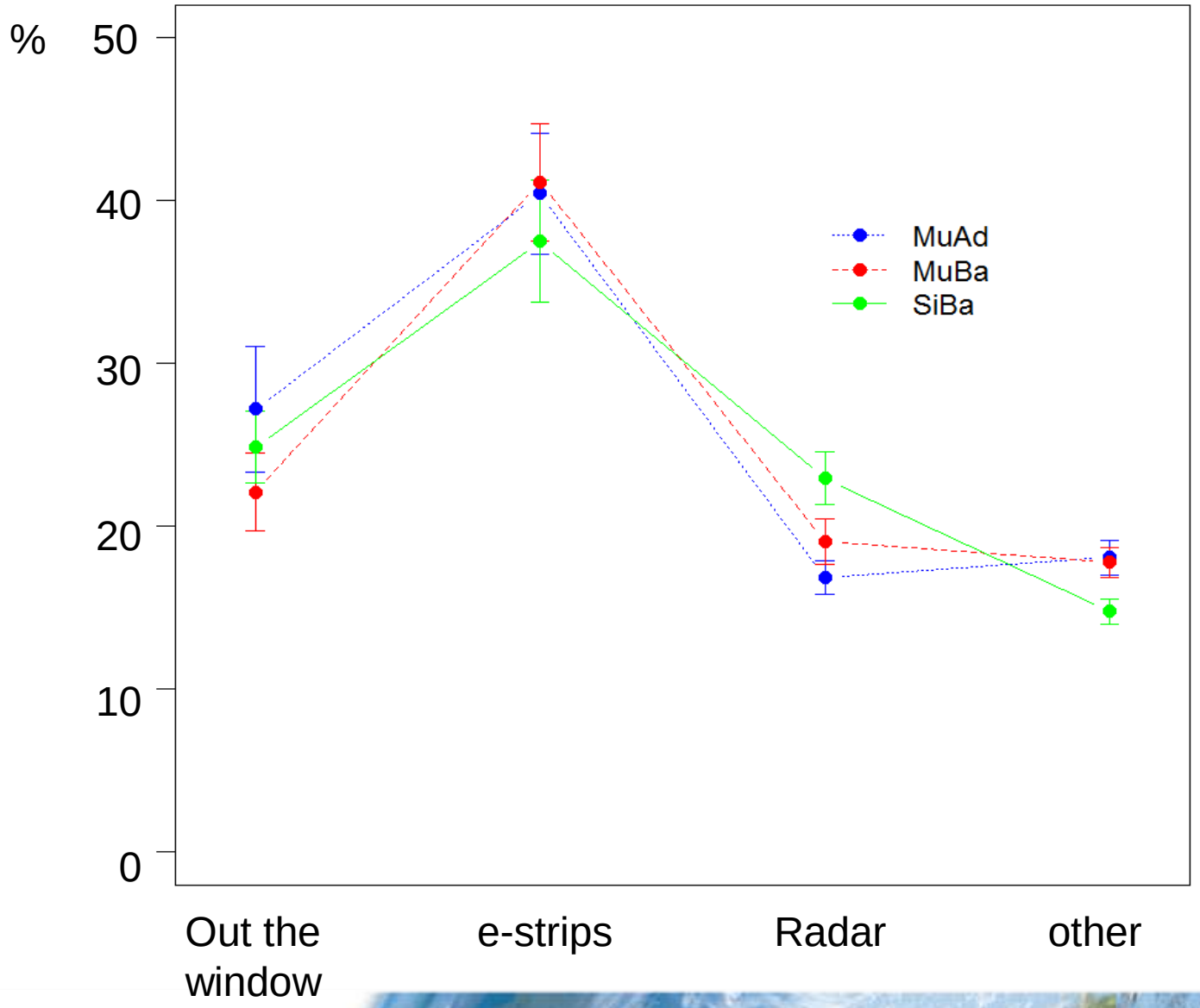


% aller Starts und Landungen beobachtet:

Multiple Remote: 82,7%

Single Remote: 93,2%

Mean Dwellfixes (N=16)



Important Results of our Research

- Operational and technical proof of feasibility:
  - Operational & Performance Requirements
  - Situational Awareness
  - Usability
  - Acceptance
  - Safety Risk Assessment
  - Workload
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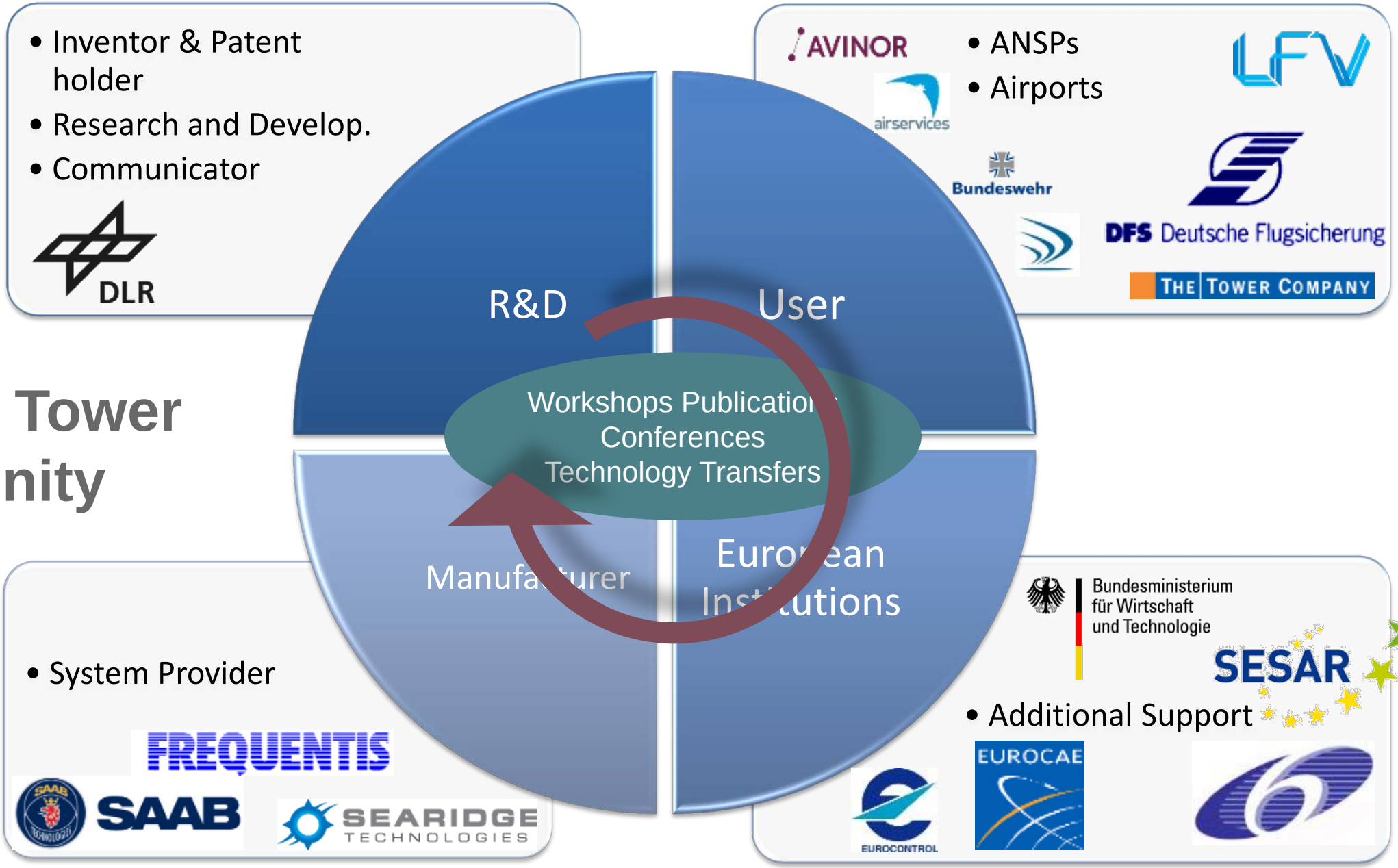
➔Feasibility proven!

DLR Remote Field-Test-Plattform, Research Airport Braunschweig

Remote Tower Community



New Features: Ultra-HD Resolution for Remote Apron Control

Hi-Res-Camera:

1920 x 2880 pixel in use

17mm lens with lens shift

1“/pix resolution (human eye)

35°x 50° Field of View/camera

Hi-Res-Display-Wall with SquareTile-Displays:

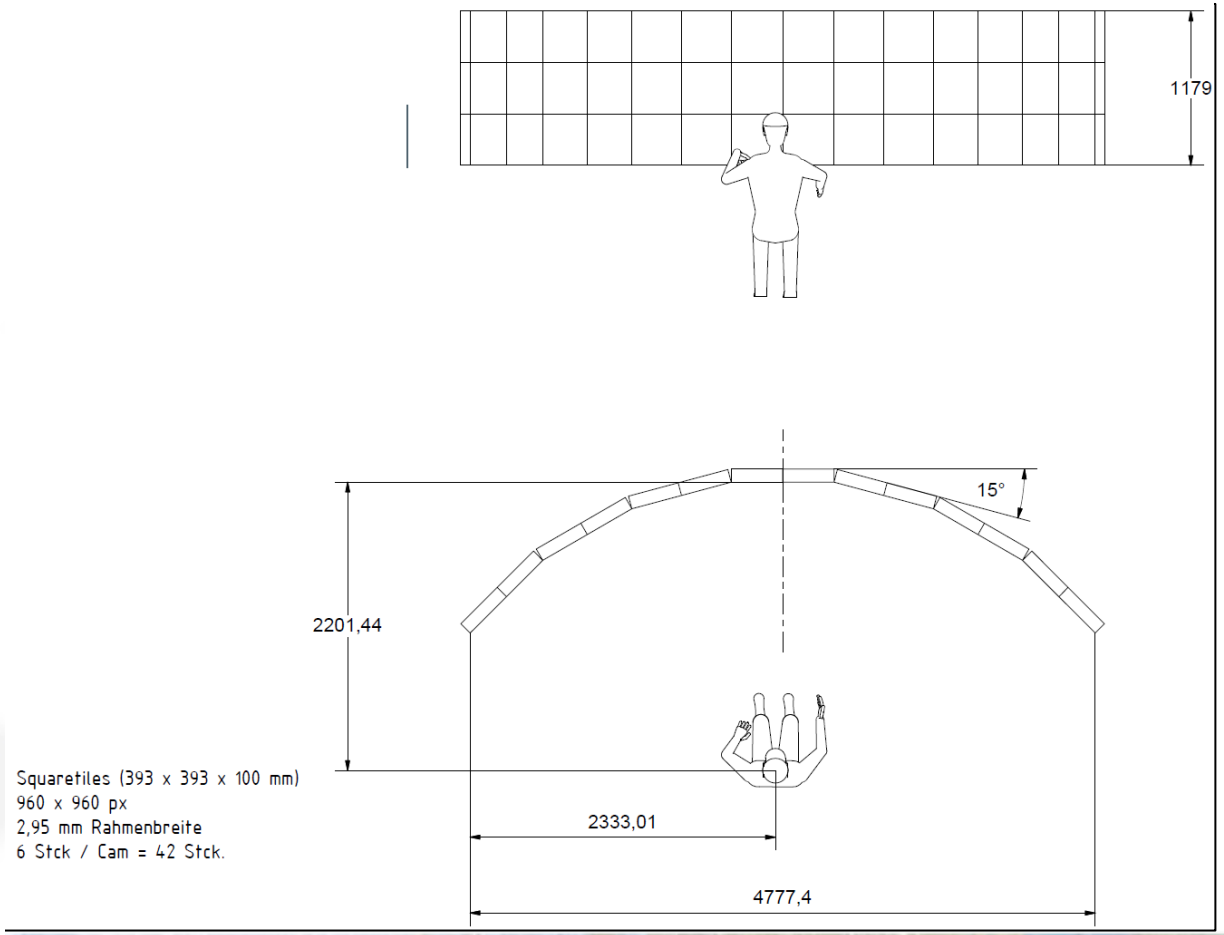
6 x 960x960 pixel/Camera

-> 1920 x 2880 pixel

Ultra narrow bezel design

Display Wall System (42 displays)

255° x 50°- panorama view (hor. x vert.) with 7 cameras

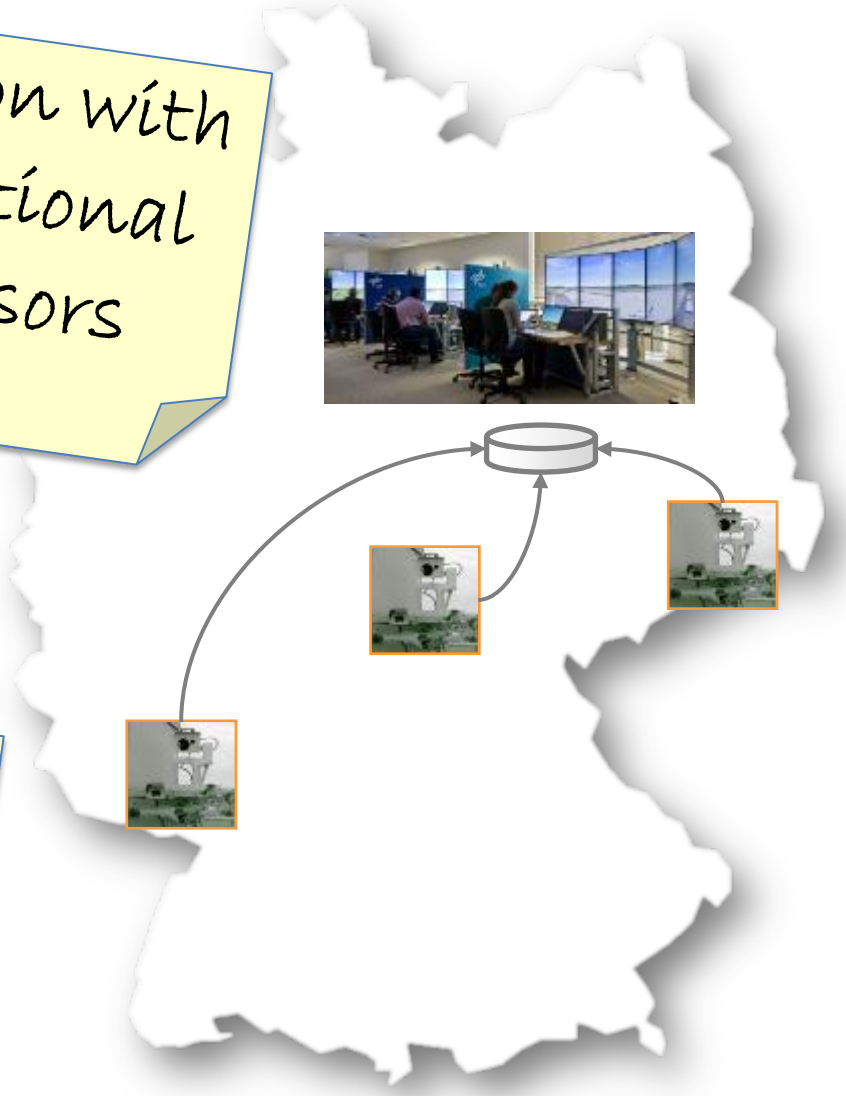


What is still to be done?

Concept Design

Decision Support Tools

Fusion with additional sensors



Best HMI Design

Certification and Standardisation

Where are we today?

A Vision has become Reality

Most recent Field-Test-Platform, DLR Braunschweig